

# **A Review on Crop Regulation Techniques in Guava (*Psidium guajava* L.) through Hi-Tech Practices**

## **ABSTRACT**

Guava (*Psidium guajava* L.) is one among the foremost favorable fruit crops of India that's considered to be the well-executed nutritionally valuable and profitable crop. Recently, guava has secured higher in demand within the global trade because of its nutritional value and processed products. It is hardy, prolific bearer and fairly remunerative fruit crop. It is mainly cultivated on the basis of commercial scale. Guava fruit bears three bahar seasons viz., Ambe bahar, Mrig bahar and Hasth bahar. The continual bearing habit ends up in the reduction of yield with inferiority small size fruits. So as to overcome this problem, bahar treatment is practiced. Among the three bahar seasons, the heaviest flowering is observed in Ambe Bahar season, but the fruit quality of this season are rough, watery, insipid in taste, poor in quality, less nutritive and are heavily attacked by many insects, pests and diseases. The fruit quality of winter season crops is excellent, nutritive and escapes from the attack of fruit flies. Therefore, the crop regulation practice is to force the tree for rest and produce profuse blossom and fruits throughout any one of the two or three flushes. It is necessary to reduce the fruit set during the rainy season and subsequently increase the fruit set during winter season through the use of various chemicals like NAA, ethereal and urea etc to regulate the guava crop. This method aims at regulating uniform and good quality fruit and also maximizing produce as well as profit. This regulation method depends on climatic factors, cropping pattern, extend of the damage by the disease and pests, market and industry demand, cultivar, etc. Crop regulation is accomplished by the various strategies like water management to induce stress, training and pruning of shoots and roots at different levels as well as at different times and manual or chemical thinning of flowers.

**Keywords:** *Crop regulation; guava; productivity; quality*

## **1. INTRODUCTION**

Guava (*Psidium guajava* L.) is the fifth most promising commercial fruit crop of India; belongs to the family Myrtaceae, is native of tropical America and is one of the most important tropical and subtropical fruit. It is easily available in market that offering reasonable price thus named as Apple of Tropics and Super Fruit for its rich nutritional values [1,2]. It is also called as Poor Man's Apple. It is a decent source of Vitamin C (150-200 mg/100 g of pulp). It has gained considerable prominence and consumer access on account of its high nutritive value. Guava fruit contains antioxidant properties that control the systolic pressure level. Guava fruit have three distinct flowering seasons viz spring (Ambe Bahar), rainy (Mrig Bahar) and autumn (Hasta Bahar) with the corresponding harvesting periods during the rainy, winter and spring seasons [3]. There are Ambe bahar- february to march flowering and their fruit ripens in july – august, Mrig bahar – june to july flowering and their fruit ripens in october to december as well as Hasth bahar – october to november flowering and fruit ripens in february to april [4]. The heaviest flowering is observed in rainy season cropping because of profuse humidity and emergence of current shoots which bears fruit bud in leaf axils and fruit. But, the bearing fruits of rainy season crop are rough, insipid, poor in quality, less nutritive and are attacked by several insect pests and diseases [5]. On the other hand, fruits in winter season are superior in size, quality, taste, aroma and also crop; free from diseases and pests so; get

higher price than rainy season crop with better demand in the market [6]. Winter season crop has better storage life therefore, it can be transported to destination with remunerative prices [7]. However, it is desirable to take only one crop every year. This requires various management of flowering to obtain the most desirable crop, by different methods like withholding irrigation, pruning and flower thinning by chemically or manually. Therefore, various scientists and their coworkers reviewed on crop manipulation under different sub heads.

## **2. CROP REGULATION AND ITS IMPORTANCE**

In guava, summer season (Ambe bahar) bears more flowers due to the break of winter stress. So, it produces more fruits during rainy season. However, in this season due to high temperature and rainfall during fruit maturation, the duration of fruit maturation is reduced to 30 days that causes excess in the market while winter season crop (Mrig bahar) is superior in quality which obtains remarkably higher price. However, the rainy season guava bears excess fruit production [3, 8] but it offers poor quality due to insipid in taste and infestation of pest comparatively to winter season [9]. On the contrary, the fruit quality of winter season is good and free from diseases and pests and fetches high monetary returns [10]. Guava fruit harvest peaks can diverge with prevailing weather conditions and cultural practices because flowers are induced on new growth. Therefore, for getting the quality fruits in guava only winter season crop should be taken comparatively to rainy season crop. This requires the regulation of flowering to obtain the most desirable crop by withholding irrigation, thinning of flowers through chemically or manually, pruning, bending, root exposure, etc. In different regions various methods of crop regulations are followed which depend upon the climatic factors, cropping pattern, cultivar etc. Crop regulation is practiced in guava to encourage particular season crop so as to induce quality fruit with high commercial value. The fundamental principle of crop regulation is to manipulate the natural flowering and fruiting of guava plant in desired season of the year that contribute to accumulated fruit yield, quality, profitability and property of the surroundings by reducing the utilization of the frequency of the pesticides [11]. This idea relies on the actual fact that guava flowers are borne solely on new, succulent, smartly rising vegetative growths. These new growth flushes is either new emergences of lateral bud on older stems or extensions of already established terminals of varied size and vigor.

## **3. METHODS OF CROP REGULATION IN GUAVA**

Several methods have been used to induce new vegetative growth during rainy season so that more crops are obtained in subsequent winter season [10]. The following practices carried out by various scientists on crop manipulation are reviewed under different sub heads in order to get the fruit crop in winter season.

### **a) Withholding irrigation method**

In guava the induction of water stress by withholding irrigation after harvesting of winter crop results in the shedding of flowers and the trees goes to rest. The operations of withholding water exhibit feeding roots and also pruning the fibrous roots to force blossom in the desired season. June flowering is inspired to get winter crop; for that, the basin of the tree is dug up, manured and irrigated in June. After 20-25 days of fertigation, the tree offers profuse flowering in July and fruiting in winter season. Water stress may be induced by practices like root exposure and root pruning. It has suggested that withholding of water and removing the earth from around the upper roots by 10<sup>th</sup> June and again covering it with soil and manure mixture [12]. Two irrigations were also suggested before a normally heavy one when the rains did not start. Likewise, it has also suggested root pruning practice is done along with withholding irrigation in heavier soils during December or January [13].

### **b) Bending method of guava shoots**

Bending method is very much dependent on the training of guava branches. On the basis of calculation of expected flowering the branches of guava plants are bent down about 45-60 days before the expected date of flowering and to produce fruits in the off season. Initially bending of branches of guava plant ought to use at the age of 02 (two) years of plant. Before bending the leaves small shoots, flowers and fruits from branch are removed or cut off keeping 10- 12 inches of terminal twigs intact. During autumn

(September-November) the new shootlets take 20-25 days to emerge. Bent branches ought to be untied once the new shootlets are about 1 cm in length. Flowering occurs in the new shootlets at 4-5 pairs of leaf stage after 45-50 days of summer and 60-65 days of autumn bending. Manures and fertilizers should be applied 15 days before bending of branches and again at pea stage of fruit growth followed by irrigation [14].

### **c) Hand thinning method**

It is possible to regulate cropping pattern in guava by hand thinning of flower buds and thinning of flowers during the months of March and April in Red Flushed, Allahabad Safeda and Sardar varieties which has proved to be the most effective in reducing size of rainy season crop by withholding water [15].

### **d) Pruning and exposure techniques**

Annual pruning is used as a cheap and effective culture technique for regulating cropping pattern and increasing fruit yield and quality in guava [16]. It has reported that maximum number of fruits in winter crop found from guava trees when three-fourth shoot length pruned during May [14]. The practice is popularly known as elicit treatment and is achieved by root exposure and root pruning or exposure to hot sun before the onset of monsoon. Root pruning, however has a harmful effect on the longevity of trees [17]. It has studied the effect of pruning on vegetative growth, flowering and fruiting in Sardar guava favored the production of more flowers in July-August flush thereby more fruits in winter season. [17,18]. It has also reported that 50 per cent shoot pruning of guava cv. L-45 (Sardar) in May produced the highest fruit yield of winter crop [17].

### **e) Deblossoming techniques**

Some of the plant growth regulators (NAA, NAD, 2, 4-D, carbaryl and ethrel) or certain chemical compounds have been found very effective in thinning of flowers, increasing the winter crop as well as manipulating the cropping season under different agro-climatic conditions. Post-bloom application of NAA @ 80- 100 ppm has been useful in reducing fruit set. This treatment can reduce more than 80 % of rainy season crop and also increase flowering of the winter crop. The spray of 2, 4-D @ 30ppm also found to be effective for de-blossoming in summer flower. Manual deblossoming of rainy season flowers at small scale, kitchen garden and early age of the plant is very effective as compared to large commercial plantation. Flower thinning by using naphthalene acetic acid (NAA), naphthalene acetamide (NAD), 2,4-dichlorophenoxy acetic acid (2,4-D), potassium iodide (KI), ethephon, 4,6-dinitro-ocresol (DNOC) and urea have been tried with varying degree of success. This variation may be due to cultivars, tree condition, soil type and environment. Most of the workers are of the opinion that chemical thinning is economic and it increases the winter yield and also helps in improvement of fruit quality. In guava, deblossoming with NAA @ 600ppm prevents flowering and cropping during rainy season in order to augment cropping in winter season. It has found that 15 per cent urea at 50 per cent bloom stage showed most effective in deblossoming during the rainy season guava crop [19]. Similar results have been reported by Tiwari and Lal (2007) [20].

## **4. Effect of crop regulation on floral and yield parameters**

In general, guava tree bear flowers twice in a year, i.e. in april-may and august-september, of that fruits ripen in rainy and winter seasons severally [21]. Sometimes, a third flowering happens in october-november, particularly in Maharashtra and Tamil Nadu [22]. Floral buds seem presently once the break of winter stress and new growth start in the axil of the leaves of guava crop. Flower bud seems produce after the maturation of first pair of leaves, but there is no direct association between leaf appearance and flower production [23]. Flowers occur either on an individual basis or in determinate of 2-3 at leaf axils of current [24]. The bearing twigs usually grow a few centimeters putting forth 4-5 pairs of leaves and thereafter, either flower buds start developing or twigs cease to grow till the next season. These are the following floral and yield parameters affected by crop regulations.

- a) **Number of flowers:** The flower number in guava depends upon the season, varietal selection and varied cultural operations including PGR etc. In pruned trees of guava, 70 to 83 per cent of laterals flowered whereas in unpruned trees solely 40 to 60 per cent of laterals floral and the

flower initiation and flower production are also hastened [25]. Similarly, there was also observed that tipping terminal portion of tender shoot hastened the production of flowers per shoot compared to untipped shoots in guava [26]. There was also observed that the annual pruning of guava stimulated the flower [27, 28].

- b) **Fruit set:** To influence the guava crop within the desired season, it is essentially to reduce the fruit set during the rainy season and thereafter increase the fruit set during winter season by the use of different chemicals [29], [30]. It has recorded that the reduced fruit set during the rainy season with spray of NAA@1000 and 2000 ppm [31]. Similar results were also obtained when spray of NAA @ 600 ppm [32]. When application of high concentration of urea affects fruit set during rainy season [33]. Similar types of result was obtained when apply 10 percent of urea solution to reduce fruit set [34]. It was also reported that withholding irrigation method also reduces the fruit set in guava during rainy season crop [35]. Similar results also showed in root exposure and root pruning methods [36]. There was obtained maximum fruit set during monsoon by 30 cm shoot pruning [37].
- c) **Fruit size:** It depends upon number of fruit season and genetic makeup of variety. It was reported that pruned trees of guava produced larger fruits than unpruned trees [38]. Similar result were also observed that pruning of guava trees increase fruit size [37]. When thinning of flowers and young fruits done, the size of fruit will increase [29]. The fruit length and fruit diameter also increased by the use of growth substances [29,38]. The fruit size improved in both rainy and winter season crops by the utilization of various thinning chemicals [29,39]. However, It was reported that the fruit size of guava improved by all NAA, urea, ethephon and potassium iodide treatments during rainy and winter seasons but fruit length was found maximum in 10 per cent urea [40]. Similarly, it has also seen that the maximum fruit size with application of 10 per cent urea during rainy season [41].
- d) **Fruit weight:** Generally, it depends upon the number of the fruits season and genetic makeup of variety in addition to other cultural practice. It has obtained increased fruit weight found in Allahabad Safeda through crop regulation practices [24]. Similar result were obtained by manual removal of flowers to increase fruit size in Sardar variety of guava [29].When the application of growth substances like NAD (30 and 50 ppm) to increase fruit weight [29]. Likewise, it has also reported that the application of various chemicals increases the fruit weight of guava plants during both rainy and winter season crops [42]. The application of NAA @ 600 ppm at full bloom stage to increase fruit weight [43]. The application of NAA @ 100 ppm at full bloom stage same type of results were produced [34]. However, it had reported that all treatments like NAA, ethephon, urea and potassium iodide improved the mean fruit weight of Sardar guava and the maximum fruit weight with the application of 10 percent urea spray during both rainy and winter season crops [40].
- e) **Fruit yield:** The fruit yield is an ultimate factor that decides the success and failure of any technology in the favors of the fruit growers. The rainy season crop found minimum effectively by the use of various chemicals and also obtained a subsequent good winter season crop [30]. Similarly, it was reported good winter crop obtained when rainy season crop reduced effectively with the spray of NAA @600 ppm [21]. There was also reported that one leaf pair pruning decreased the fruit yield per tree during rainy season and subsequently increased the fruit yield during winter season [44]. Similarly, it had obtained the highest yield in lightly pruned (30cm) guava trees and minimum in severely pruned guava during the rainy season [37]. However, pruning done in the current season's growth of spring flush advocated to avoid the rainy season crop and to get a subsequent good winter crop [42]. Likewise, there was reported that pruning of half current season's crop and a subsequent good crop in winter season [45]. Similar observations were also made by Singh and Kumar,1993 [46]. Hand thinning of flowers reduced the rainy season yield and increased winter crop but total annual yield was lower [29]. Hand

thinning of flowers too expensive and cumbersome so these practices commonly not be used [27,42].

## 5. EFFECT OF CROP REGULATION ON QUALITY CHARACTERS

The crop regulation is to manipulate the natural flowering of the guava plant in preferred season that contribute to improved fruit yield, quality and profitability. Therefore, some important quality parameters are affected by the crop regulation practices which are as follows:

- a) **Sugars:** The sugar content of fruit from pruned and chemically treated guava tree is influenced in both seasons of the cropping. There was reported that pruning method helped in increasing the total sugar content of guava fruit [37]. Similar results were also observed that increased total sugars contents due to pruning in both the seasons [47]. Whereas, the application of NAA@30 ppm to increase the total sugars in guava fruits [29]. Different chemical treatments such as NAA, ethephon and urea had a significant effect on the percentage total sugar contents during rainy and winter season guava fruits [48].
- b) **Total soluble solids (TSS):** Total soluble solids is the index of fruit sweetness. Different thinning treatments proved superior in the TSS content improvement of guava fruits throughout rainy and winter season crops [49]. It was found a significant improvement in the TSS content with potassium sulphate @1% once sprayed 07 days after fruit set in guava and six more times at weekly intervals [50]. Similarly, there were obtained the improved TSS content with the spray of potassium iodide at flowering time in guava during both rainy and winter season crops [39]. Whereas, it was also observed an appreciable improvement in TSS content with totally different chemical treatments (NAA, 2, 4-D, DNOC and urea) as compared to control during both rainy and winter season crops of Sardar guava [34]. Likewise, it was recorded the higher TSS content with spray of urea@10% at full bloom stage of guava during both rainy and winter season crops [43]. Similar results were also made by Bariana, 1988 [41]. Pruning resulted in better quality fruits during the rainy season [51]. Similar results were obtained in 5 Navalur guava cultivars [52].
- c) **Vitamin C:** The antioxidant content of guava fruit is influenced by the varied crop manipulation treatments. The work carried out by the various workers is summarized as under more vitamin C content was recorded in a variety Allahabad Safeda during winter seasons (241.66 mg/100 g) by pruning treatment compared to the rainy season (90.66 mg/ 100 g) [47]. Application of 12 ppm 2, 4-D increased vitamin C content (202.18 mg/100g) [53]. Similarly, it was also found maximum vitamin C content with the spray of NAA@125 ppm in both rainy (174.6 mg/kg) and winter (253.7 mg/100g) seasons [29].
- d) **Acidity:** In general, the acidity of the fruit varies with the seasons i.e. in summer acidity is usually less as compared to winter season. The application of 40 and 80 ppm NAA in guava during the rainy season, acidity content of the fruit was slightly reduced [54]. Pruning treatment in Allahabad Safeda variety of guava cause lower acidity [37]. It has found minimum acidity in both the seasons by the spray of NAA@100 ppm [29]. While, it has reported that the acidity of fruits was reduced in rainy and winter seasons with the spray of NAA@100 ppm [42].
- e) **Pectin:** It is an important component of guava fruit which influenced by various treatments of pruning, chemical thinners, plants growth regulator, season of cropping and water stresses. It was reported that the highest percentage of pectin in guava fruits by the manual removal of flowers [42]. Application of 2, 4-D @ 12 ppm increased the pectin content in fruits of commercial cultivars [53]. But the application of NAD @ 50 ppm increased the pectin content significantly [42]. whereas it was also recorded highest pectin content with the spray of 4 and 6 percent urea when applied twice i.e. in January and July [56].

## 6. CROP REGULATION FOR ECONOMIC BENEFITS

In India, customers and marketers are always demanding quality guava fruits. The two most popular cultivars of guava i.e., Allahabad Safeda and Sardar both are intrinsically poor in quality throughout time of the year [57]. But winter season crop bears quality fruits that fetch high monetary returns [10]. Hence,

crop regulation methodology will facilitate to overcome such issues to an excellent extent by judicious flower thinning during summers. This system can facilitate to optimize the harvest time which reduce surplus within the market, to get higher worth of the produce, to avoid spoilage due to excessive production at a particular time, to generate employment throughout the year and balance the trade and to reduce imports. According to research, maximum and statistically higher yield (119.73 q/ha), gross return (Rs. 32925 per hectare) and net return (Rs 230529 per hectare) as well as cost benefit ratio (1:3.33) were obtained under the application of 800 PPM NAA plant growth regulator [58]. Similarly, it was reported significantly higher yield (100 kg/tree) was found in Allahabad Safeda with spray of 10 % urea during winter season, while Sardar guava recorded highest yield (103.98 kg/tree) with the spray of 1800 ppm ethephon during the same season which was closely followed by 20 and 15 % urea (100.25 and 96.38 kg/tree, respectively) [10]. It was also found highest benefit: cost ratio (i.e., 7.84:1) by summer deblossoming with spray of NAD@ 60 ppm [59]. Similarly, it was also noticed that Pant Prabhat cultivar was more profitable with cost: benefit ratio of 1:2.96 by one leaf pair pruning of fruited shoots [60]. This treatment recorded the highest return which was distributed in rainy as well as in winter season.

## 7. CONCLUSION

Crop regulation in guava can be adopted successfully by using various cultural and chemical methods. Differential studies by research workers have substantially advocated that the application of various cultural and chemical methods is effective to regulate the flowering of summer season flowers and to produce fruits in winter. The outcome of different studies reported by scientists in guava has revealed that the fruits of winter season were considerably superior in each respect like attractive size, weight and better internal bio-quality parameters than the fruits of rainy season which helped to fetch the remunerative price of fruits to growers as well as affordable price to consumers. Depending upon the supply of workforce and chemicals, an appropriate technique suited to edaphic conditions ought to be adopted to get higher quantitative and qualitative outcome of fruits from guava orchards.

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